

Appl. No. 09/432,338
Att. Docket No. 10191/1157
Response To Office Action of 05/21/03

Amendments to the CLAIMS:

Without prejudice, this listing of the claims replaces all prior versions and listings of the claims in the present application:

LISTING OF CLAIMS:

1-7. (Canceled).

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8. (New) A method of activating an electromagnetic consumer having a movable element, the electromagnetic consumer including a solenoid valve to control a metering of fuel being injected to an internal combustion engine, the method comprising:

defining a duration of a time window in which the electromagnetic consumer is in a closed state, the duration being such that a switching instant of the electromagnetic consumer occurs within the time window, the switching instant being detectable within the time window, and any rise in current in the electromagnetic consumer does not disconnect an output stage of the electromagnetic consumer, wherein the time window has a starting lower time and an ending upper time, and the lower time and the upper time are each defined based on the switching instant and the duration of the time window;

wherein the electromagnetic consumer is controlled by a switching arrangement, and current flowing through the electromagnetic consumer is measured by a current measuring arrangement, and

wherein a current characteristic of the electromagnetic consumer has at least one of a break and a discontinuity at the switching instant.

9. (New) The method of claim 8, wherein the lower time occurs after a starting consumer current is reached.

10. (New) The method of claim 9, wherein the upper time occurs before a holding consumer current is reached.

11. (New) The method of claim 8, wherein the upper time occurs before a holding consumer current is reached.

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12. (New) The method of claim 8, wherein the lower time corresponds to the switching instant minus a duration function, and the upper time corresponds to the switching instant plus the duration function.

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13. (New) The method of claim 12, wherein the duration function corresponds to a fraction of the duration of the time window.

14. (New) The method of claim 12, wherein the duration function corresponds to one-half of the duration of the time window.

15. (New) The method of claim 8, wherein a present maximum value of a current in the time window increases as the duration of the time window increases.

16. (New) The method of claim 8, wherein the present maximum value of the current in the time window does not reach a threshold current.

17. (New) The method of claim 16, wherein the threshold current is less than a maximum allowed current value in the time window.

18. (New) The method of claim 16, wherein the threshold current is a function of a battery voltage received by the electromagnetic consumer.

19. (New) The method of claim 16, wherein the threshold current increases during a startup operation.

20. (New) The method of claim 8, wherein the movable element reaches an end position at the switching instant.

21. (New) The method of claim 8, wherein the current measuring arrangement includes an ohmic resistor.

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22. (New) The method of claim 8, wherein the switching arrangement includes a transistor.

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23. (New) The method of claim 8, wherein the movable element reaches an end position at the switching instant, the current measuring arrangement includes an ohmic resistor, and the switching arrangement includes a transistor.

24. (New) A method of activating an electromagnetic consumer having a movable element, the electromagnetic consumer including a solenoid valve to control a metering of fuel being injected to an internal combustion engine, the method comprising:

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determining a duration of a time window in which the electromagnetic consumer is in a closed state, the duration being such that a switching instant of the electromagnetic consumer occurs within the time window, the switching instant being detectable within the time window, and any rise in current in the electromagnetic consumer does not disconnect an output stage of the electromagnetic consumer, wherein the time window has a starting lower time and an ending upper time, and the lower time and the upper time are each defined based on the switching instant and the duration of the time window, wherein the electromagnetic consumer is controlled by a switching arrangement, and current flowing through the electromagnetic consumer is measured by a current measuring arrangement, and wherein a current characteristic of the electromagnetic consumer has at least one of a break and a discontinuity at the switching instant; and

wherein the determining of the duration is performed by performing the following operations following a starting of the internal combustion engine:

- (a) setting the duration to a minimum duration;
- (b) determining whether a present maximum current in the time window is greater than a threshold current;
- (c) if the present maximum current in the time window is not greater than the threshold current, then increasing the duration by a first amount;
- (d) determining whether the duration of the time window is greater than a maximum duration, and if not, returning to (a), and if so then stopping;
- (e) if the present maximum current in the time window is greater than the threshold current, then decreasing the duration by a second amount;

(f) determining whether the duration is not greater than the minimum duration, and if not, returning to (a), and if so, setting the duration to the minimum duration and returning to (a).

25. (New) The method of claim 24, wherein the duration of the time window is increased from the minimum duration if the current in the time window is not greater than the threshold current, the duration of the time window is increased until the maximum duration is reached, and the duration of the time window is decreased if the current in the time window is greater than the threshold current.

26. (New) The method of claim 24, wherein at least one of the first amount and the second amount is a fixed amount.

27. (New) The method of claim 24, wherein the present maximum current in the time window corresponds to a current in the time window at the upper time.

28. (New) The method of claim 24, wherein the present maximum current in the time window corresponds to a current immediately before the upper time.

29. (New) The method of claim 24, wherein the first amount is a fixed amount and the second amount is a fixed amount, the present maximum current in the time window corresponds to one of a current at the upper time and a current immediately before the upper time.

30. (New) The method of claim 24, wherein the lower time occurs after a starting consumer current is reached.

31. (New) The method of claim 30, wherein the upper time occurs before a holding consumer current is reached.

32. (New) The method of claim 24, wherein the upper time occurs before a holding consumer current is reached.

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33. (New) The method of claim 24, wherein the lower time corresponds to the switching instant minus a duration function, and the upper time corresponds to the switching instant plus the duration function.

34. (New) The method of claim 33, wherein the duration function corresponds to a fraction of the duration of the time window.

35. (New) The method of claim 33, wherein the duration function corresponds to one-half of the duration of the time window.

36. (New) The method of claim 24, wherein a present maximum value of a current in the time window increases as the duration of the time window increases.

37. (New) The method of claim 24, wherein the present maximum value of the current in the time window does not reach a threshold current.

38. (New) The method of claim 37, wherein the threshold current is less than a maximum allowed current value in the time window.

39. (New) The method of claim 37, wherein the threshold current is a function of a battery voltage received by the electromagnetic consumer.

40. (New) The method of claim 37, wherein the threshold current increases during a startup operation.

41. (New) The method of claim 24, wherein the movable element reaches an end position at the switching instant.

42. (New) The method of claim 24, wherein the current measuring arrangement includes an ohmic resistor.

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43. (New) The method of claim 24, wherein the switching arrangement includes a transistor.

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44. (New) The method of claim 24, wherein the movable element reaches an end position at the switching instant, the current measuring arrangement includes an ohmic resistor, and the switching arrangement includes a transistor.

45. (New) The method of claim 24, wherein:

the lower time occurs after a starting consumer current is reached;
the upper time occurs before a holding consumer current is reached;
the lower time corresponds to the switching instant minus a duration function, and the upper time corresponds to the switching instant plus the duration function;
the duration function corresponds to a fraction of the duration of the time window.
a present maximum value of a current in the time window increases as the duration of the time window increases;
the present maximum value of the current in the time window does not reach a threshold current; and
the threshold current is less than a maximum allowed current value in the time window.

46. (New) The method of claim 45, wherein the duration function corresponds to one-half of the duration of the time window.

47. (New) The method of claim 45, wherein the threshold current is a function of a battery voltage received by the electromagnetic consumer.

48. (New) The method of claim 45, wherein the threshold current increases during a startup operation.

49. (New) The method of claim 45, wherein the movable element reaches an end position at the switching instant.

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50. (New) The method of claim 45, wherein the current measuring arrangement includes an ohmic resistor.

51. (New) The method of claim 45, wherein the switching arrangement includes a transistor.

52. (New) The method of claim 45, wherein the movable element reaches an end position at the switching instant, the current measuring arrangement includes an ohmic resistor, and the switching arrangement includes a transistor.

53. (New) An arrangement to control an electromagnetic consumer having a movable element, the electromagnetic consumer including a solenoid valve to control a metering of fuel being injected to an internal combustion engine, comprising:

a control arrangement to control a switching arrangement, and to determine a duration of a time window in which the electromagnetic consumer is in a closed state, the duration being such that a switching instant of the electromagnetic consumer occurs within the time window, the switching instant is detectable within the time window, and any rise in current in the electromagnetic consumer does not disconnect an output stage of the electromagnetic consumer, wherein the time window has a starting lower time and an ending upper time, and the lower time and the upper time are each defined based on the switching instant and the duration of the time window;

wherein the electromagnetic consumer is controlled by the switching arrangement, and current flowing through the electromagnetic consumer is measured by a current measuring arrangement coupled to the control arrangement, and

wherein a current characteristic of the electromagnetic consumer has at least one of a break and a discontinuity at the switching instant.

54. (New) The arrangement of claim 53, wherein the determining of the duration is performed by performing the following operations following a starting of the internal combustion engine:

(a) setting the duration to a minimum duration;

(b) determining whether a present maximum current in the time window is greater than a threshold current;

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(c) if the present maximum current in the time window is not greater than the threshold current, then increasing the duration by a first amount;

(d) determining whether the duration of the time window is greater than a maximum duration, and if not, returning to (a), and if so then stopping;

(e) if the present maximum current in the time window is greater than the threshold current, then decreasing the duration by a second amount;

(f) determining whether the duration is not greater than the minimum duration, and if not, returning to (a), and if so, setting the duration to the minimum duration and returning to (a).

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55. (New) The arrangement of claim 54, wherein the duration of the time window is increased from the minimum duration if the current in the time window is not greater than the threshold current, the duration of the time window is increased until the maximum duration is reached, and the duration of the time window is decreased if the current in the time window is greater than the threshold current.

56. (New) The arrangement of claim 53, wherein at least one of the first amount and the second amount is a fixed amount.

57. (New) The arrangement of claim 53, wherein the present maximum current in the time window corresponds to a current in the time window at the upper time.

58. (New) The arrangement of claim 53, wherein the present maximum current in the time window corresponds to a current immediately before the upper time.

59. (New) The arrangement of claim 53, wherein the first amount is a fixed amount and the second amount is a fixed amount, the present maximum current in the time window corresponds to one of a current at the upper time and a current immediately before the upper time.

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60. (New) The arrangement of claim 53, wherein the lower time occurs after a starting consumer current is reached.

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61. (New) The arrangement of claim 60, wherein the upper time occurs before a holding consumer current is reached.

62. (New) The arrangement of claim 53, wherein the upper time occurs before a holding consumer current is reached.

63. (New) The arrangement of claim 53, wherein the lower time corresponds to the switching instant minus a duration function, and the upper time corresponds to the switching instant plus the duration function.

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64. (New) The arrangement of claim 63, wherein the duration function corresponds to a fraction of the duration of the time window.

65. (New) The arrangement of claim 63, wherein the duration function corresponds to one-half of the duration of the time window.

66. (New) The arrangement of claim 53, wherein a present maximum value of a current in the time window increases as the duration of the time window increases.

67. (New) The arrangement of claim 53, wherein the present maximum value of the current in the time window does not reach a threshold current.

68. (New) The arrangement of claim 67, wherein the threshold current is less than a maximum allowed current value in the time window.

69. (New) The arrangement of claim 67, wherein the threshold current is a function of a battery voltage received by the electromagnetic consumer.

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70. (New) The arrangement of claim 67, wherein the threshold current increases during a startup operation.

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71. (New) The arrangement of claim 53, wherein the movable element reaches an end position at the switching instant.

72. (New) The arrangement of claim 53, wherein the current measuring arrangement includes an ohmic resistor.

73. (New) The arrangement of claim 53, wherein the switching arrangement includes a transistor.

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74. (New) The arrangement of claim 53, wherein the movable element reaches an end position at the switching instant, the current measuring arrangement includes an ohmic resistor, and the switching arrangement includes a transistor.

75. (New) The arrangement of claim 53, wherein:

- the lower time occurs after a starting consumer current is reached;
- the upper time occurs before a holding consumer current is reached;
- the lower time corresponds to the switching instant minus a duration function, and the upper time corresponds to the switching instant plus the duration function;
- the duration function corresponds to a fraction of the duration of the time window.
- a present maximum value of a current in the time window increases as the duration of the time window increases;
- the present maximum value of the current in the time window does not reach a threshold current; and
- the threshold current is less than a maximum allowed current value in the time window.

76. (New) The arrangement of claim 75, wherein the duration function corresponds to one-half of the duration of the time window.

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77. (New) The arrangement of claim 75, wherein the threshold current is a function of a battery voltage received by the electromagnetic consumer.

78. (New) The arrangement of claim 75, wherein the threshold current increases during a startup operation.

79. (New) The arrangement of claim 75, wherein the movable element reaches an end position at the switching instant.

80. (New) The arrangement of claim 75, wherein the current measuring arrangement includes an ohmic resistor.

81. (New) The arrangement of claim 75, wherein the switching arrangement includes a transistor.

82. (New) The arrangement of claim 75, wherein the movable element reaches an end position at the switching instant, the current measuring arrangement includes an ohmic resistor, and the switching arrangement includes a transistor.

83. (New) A method of activating an electromagnetic consumer having a movable element, the electromagnetic consumer being a solenoid valve for controlling a metering of fuel into an internal combustion engine, the method comprising:

determining within a time window a switching instant at which the movable element has reached a certain position;

defining a duration of the time window so that the current flowing through the consumer during the time window does not exceed a threshold value; and

reducing the duration of the time window if the current is greater than the threshold value.

84. (New) The method of claim 83, further comprising: increasing the duration of the time window starting from a starting value if the current is lower than the threshold value.

85. (New) The method of claim 84, further comprising: increasing the duration of the time window until a maximum value for the duration is reached.

86. (New) The method of claim 85, wherein the consumer receives a power supply voltage during the period of time, further comprising: analyzing a time variation of the current to determine the switching instant.

87. (New) The method of claim 85, further comprising: determining the current immediately before an end of the time window.

88. (New) An arrangement for activating an electromagnetic consumer having a movable element, the electromagnetic consumer being a solenoid valve for controlling a metering of fuel into an internal combustion engine, the arrangement comprising:

a determining arrangement to determine within a time window a switching instant at which the movable element has reached a certain position, and to define a duration of the time window so that the current flowing through the consumer during the time window does not exceed a threshold value; and

a reducing arrangement to reduce the duration of the time window if the current is greater than the threshold value.

89. (New) The arrangement of claim 88, further comprising: an arrangement to increase the duration of the time window starting from a starting value if the current is lower than the threshold value.

90. (New) The arrangement of claim 84, wherein the duration of the time window is increased until a maximum value for the duration is reached.